

SYSTEM AND METHOD FOR MANAGING AIR FROM A COOKTOP

BACKGROUND

[0001] The invention relates generally to systems for moving, treating and venting air in a space and, more particularly, to ventilating systems, such as those used with cooktops and the like.

[0002] Various types of systems have been designed and are in use for venting and circulating air in environments such as kitchens. In general, ventilating and circulating systems serve to remove and recirculate, or to vent air from above or adjacent to a stove, cooktop or other device. The systems draw in air and vapors that may be laden with grease and odors, clean the air, and either recirculate the air to the room or vent the air to the outside. Because the vapors and hot air rise, the systems are typically situated above the cooking surface and associated with a hood, although other systems may be located adjacent to or even in the cooking system itself.

[0003] Such kitchen ventilating systems typically include, without limitation, fans, filters for grease removal and a control system. Typical kitchen ventilating systems are designed to cover the whole area of a cooking apparatus with at least one centrifugal fan and a set of filters for grease removal. However, in many cases a user of the cooking apparatus performs the cooking activities using only a limited number of burners among the available number of burners in the cooking apparatus. The kitchen ventilating systems covering the whole area of the cooking apparatus in such cases distribute the static pressure developed by the fan on the entire area of the cooking apparatus, thus requiring higher capacity fans for effective capture of the vapors over the cooking surface. Such conventional systems thus result in relatively high energy consumption and noise generation.

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determined speed options. However, usage of these limited options may result in situations where insufficient or excess fan power is delivered, resulting in either poor capture of fumes or excess energy consumption and noise generated, respectively.

[0005] Accordingly, it would be desirable to develop a system that senses the active zone of a cooking apparatus and the target air constituents to be removed from the air. It would also be advantageous to provide a system that could utilize this information to operate the system in a most effective manner, while maintaining the flexibility to the user for operation of the system.

BRIEF DESCRIPTION

[0006] Briefly, in accordance with one aspect of the present invention a kitchen ventilation system includes a sensor for detecting a chemical composition over an active zone of a cooktop. The system also includes an air moving device for displacing air including the chemical composition and an air flow direction control device for directing air displaced by the air moving device between exhaust and recirculation flow paths. A control circuitry is coupled to the sensor, to the air moving device and to the air flow direction control device for regulating operation of the air moving device and a position of the air flow direction control device based upon signals from the sensor.

[0007] In accordance with another aspect of the present invention, a method for ventilating air over an active side of a cooktop comprises sensing a side of a cooktop on which cooking is performed and controlling an air moving device for displacing air from the cooktop and an air flow direction control device for directing air displaced by the air moving device between exhaust and recirculation flow paths based upon the sensed side of the cooktop.

DRAWINGS

[0008] These and other features, aspects, and advantages of the present invention will become better understood when the following detailed description is read with

reference to the accompanying drawings in which like characters represent like parts throughout the drawings, wherein:

[0009] FIG. 1 is a diagrammatical representation of a ventilation system for treating air adjacent to a cooktop in accordance with aspects of the present technique;

[0010] FIG. 2 depicts an exemplary display system and user inputs of a kitchen ventilation system of the type shown in FIG. 1;

[0011] FIG. 3 is a diagrammatical representation of a kitchen ventilation system of the type shown in FIG. 1, housing the components over a cooktop;

[0012] FIG. 4 is a block diagram of steps in exemplary control logic for identifying the air circulation mode of an air flow direction control device in a kitchen ventilating system based on an air quality parameter;

[0013] FIG. 5 is a block diagram representing exemplary logic for identifying an operating system for a kitchen ventilating system based upon input duct parameters and installation site parameters;

[0014] FIG. 6 is a graphical representation of exemplary settings available for a kitchen ventilating system of the type shown in FIG. 1, based upon input duct parameters;

[0015] FIG. 7 is a graphical representation of exemplary settings available for a kitchen ventilating system of the type shown in FIG. 1, based upon installation site parameters;

[0016] FIG. 8 is a graphical representation of a set of exemplary operating points available for a kitchen ventilating system of the type shown in FIG. 1, based upon input duct parameters and installation site parameters;

[0017] FIG. 9 is a diagrammatic illustration of an exemplary air circulation mode of an air flow direction control device for a kitchen ventilating system of FIG. 1;

[0018] FIG. 10 is a diagrammatic illustration of another air circulation mode of an air flow direction control device for a kitchen ventilating system of FIG. 1;

[0019] FIG. 11 depicts the flow of information on internal references and inputs for a controller of a control circuitry of a kitchen ventilation system of the type illustrated in the previous figures; and

[0020] FIG. 12 represents an exemplary overview of the display system and the power output from a controller of a control circuitry of the kitchen ventilation system illustrated in the previous figures.

DETAILED DESCRIPTION

[0021] Referring now to FIG. 1, a kitchen ventilating system 10 generally including a series of components disposed in a ventilating system housing 12. In the illustrated embodiment, the housing 12 includes sensors 14 for detecting certain vapors and their constituents, and an air moving device 16, such as a fan for displacing air. An air flow direction control device 18 controls the mode of operation of the system by directing air displaced by the device 16. An air purification device 20 may be included for cleaning or purifying the displaced air. Also illustrated in FIG. 1 are motors 22 and 24 that drive the air moving device 16, and the air flow direction control device 18, respectively. Finally, a UV source 26 may be provided for eliminating certain odors, as described below.

[0022] The housing 12 and its housed components are shown disposed over a cooktop 28 for treating air adjacent to a cooktop 28 of a cooking appliance such as a gas stove, a gas oven and so forth. In general, vapors, odors, chemical compositions, and so forth will be created or originate from one of more active zones 30 of the cooktop 28, typically those over or with which cooking operations are performed. The sensor 14 is configured to receive inputs 32 regarding the characteristics of the air above and adjacent to an active zone 30 of the cooktop 28. It should be noted that, as used herein, the term “active zone” includes an area over the cooktop where the cooking fumes, vapors, smoke and combustion byproducts are generated as a result of cooking activities of a user of the cooking apparatus. Typically, the inputs 32

received by the sensor 14 includes a chemical composition 34 of the air above the active zone 30 of the cooktop 28.

[0023] Furthermore, the sensor 14 may be configured to capture temperature 36 and humidity 38 data of the air above and adjacent to the active zone 30 of the cooktop 28 as a part of the input 32. As discussed in greater detail below, such data is used by control circuitry 40 for regulating the operation of the air moving device 16 and a position of the air flow direction control device 18.

[0024] In one embodiment, the air moving device 16 receives signals related to certain operating parameters (e.g., speed of a fan) from the control circuitry 40, for generating required static pressure by the air moving device 16. In another embodiment, the air flow direction control device 18 receives signals from the control circuitry 40 and selects a position of the air flow control device 18 for directing air displaced by the air moving device 16 between exhaust and recirculation flow paths (e.g., positions of a louver or diverting gate).

[0025] Further, air purification device 20 may be used for air purification by reducing the concentration of certain chemical compositions 34 of the displaced air through the air moving device 16. The air purification device 20 according to this embodiment may include, but is not necessarily limited to, an active device, a corona discharge device and an ultraviolet air purification device. In another embodiment, the air purification device 20 may include a filter to facilitate odor destruction and microorganism destruction of the displaced air by the air moving device 16. Alternatively, a UV-based system with the UV source 26 may be used for the destruction of the odor generated from the cooktop 28 and for the removal of any microorganisms if present in the air above and adjacent to the cooktop 28. Moreover, a grease filter may be used to capture grease entrained in the combustion byproducts from the cooking apparatus.

[0026] In operation, the sensor 14 detects the active zone 30 of the cooking apparatus and the target air constituents to be removed from the air above the active zone 30 of the cooktop 28, and provides this information to the control circuitry 40.

In addition, the sensor 14 may also be configured to detect the UV intensity of the UV based odor and microorganism reduction system. This information may be utilized by the control circuitry 40 for regulating the operation of the air moving device 16, the air flow direction control device 18 and the air purification device 20 to maintain the desired air quality.

[0027] Control circuitry 40 may include an interface 42 for facilitating interface between the kitchen ventilation system components, and a controller 44 powered by a power supply 48. The controller 44 may be hard-wired and housed in a suitable exposed or covered enclosure fixed on or even within the kitchen ventilating system housing. Alternatively, the controller 44 may be placed in a remote location. Further, the controller 44 may receive and transmit signals pertaining to the status of the air quality and corresponding control and display signals remotely via means such as, infrared, radio frequency and electromagnetic transmission signal transmission media. Additionally, the controller 44 may use the temperature 36 and humidity 38 data acquired over the cooktop 28 via sensor 14 to compute temperature and humidity-compensated response of the air quality sensor 14 to assess the change in air quality on account of elements other than temperature 36 and humidity 38.

[0028] In general, in a presently contemplated embodiment, the controller 44 offers a momentary high power operation for a pre-determined time during start-up, and later changes to an optimum power mode of operation based on air quality status. In addition, the controller 44 may have a set of predefined programs stored that can be individually executed by a user of the system.

[0029] In a present embodiment, the control circuitry 40 also includes memory circuitry 46 for storing the pre-defined programs, internal references 50 for the operation of the components of the system and so forth. The internal references 50 may include operating cycle set points 52, operating cycle timings 54, sensor look up tables 56 for the sensor 14, ventilation rate tables 58 for the air moving device 16, a timer 60, an internal counter 62, and so forth. These references and devices may be utilized by the controller 44 for deciding the operating parameters for the kitchen ventilating system 10. Further, these operating parameters are communicated as, or

used to derive output signals 68 to the air moving device 16, the air flow direction control device 18, and the air purification device 20.

[0030] Such output signals, indicated collectively by reference numeral 68, are transmitted from the controller 44 to the air moving device 16, the air flow direction control device 18 and the air purification device 20 to regulate operation of the system. Such output signals may include, without limitation, air moving device speed 70, air moving device status 72, air flow direction control device status 74 and UV source status 76. The status of the above mentioned parameters may be made available to a user of the system via a display system 66 which will be discussed hereinafter. Also, the controller 44 is configured to receive user inputs 64 which may be used by the controller 44 for deciding the operating parameters for the kitchen ventilating system 10.

[0031] FIG.2 illustrates an exemplary display system 66 and user inputs 64 of a kitchen ventilation system of the type shown in FIG. 1. The display system 66 may have different display options to indicate the status of the different components of the kitchen ventilation system 10. For example, an air moving device speed LED or numerical display 78 may be provided that is indicative of the speed of the air moving device 16. Further, air quality sensitivity LED or display 80 may be provided to display the information about the quality of the air above the cooktop 28 as sensed by the sensor 14. In addition, the display system 66 may include a timer display 82, a power-on LED 86 and a “replace filter” display 84 to indicate the status of the filter used in the air purification device 20.

[0032] In the illustrated embodiment, the user inputs 64 typically includes operation state 88, air circulation mode selection 90, start or delay option 92, operating cycle selection 94, lamp control option 96, air quality sensitivity level option 98, counter reset option 100, and so forth. The operation state 88 may set the kitchen ventilation system 10 in either manual state or auto state. The air circulation mode 90 includes settings for placing the air flow direction control device 18 in exhaust or recirculation modes.

[0033] FIG. 3 represents, diagrammatically, a kitchen ventilation system implementation 102 with certain of the components discussed above over the cooktop 28. In operation, sensor 14 receives the inputs 32 from the active side 30 of the cooktop 28. Examples of such sensors for sensing the air quality over the active side 30 of the cooktop 28 include, without limitation, heated metal oxide sensors, electrochemical gas sensors, pellistors, hot wire catalytic gas sensors, semiconductor gas sensors, photo ionization smoke detectors, thermal conductivity type gas sensors, ultrasonic gas sensors, UV flame sensors, IR temperature sensors, heat flux sensors, air velocity sensors and so forth. Further, additional sensors for example, passive infrared (PIR) sensors may be used for detecting movement of any object in the installation location. The inputs 32 received by the sensor 14 are used by the controller 44 for controlling and operating the components of the kitchen ventilation system 10. Furthermore, a grease filter 104 may be provided upstream of the sensor 14 and other components for grease removal from the air displaced with the air moving device 16.

[0034] Further, the location of the forward side 106 of the cooktop 28 and the aft side 108 of the cooktop 28 may also affect the operating parameters of the kitchen ventilating system 10. For example, the forward side 106 of the cooktop 28 may be adjacent to a wall at the installation site. Alternatively, the forward side 106 of the cooktop 28 may be adjacent to an open space. Similarly, the aft side 108 of the cooktop 28 may be either adjacent to a wall or adjacent to an open space. In addition to the sensor 14, as described above, the air moving device 16 is also coupled to a sensor 114 for detecting the speed of the air moving device 16. Further, a sensor 116 is coupled to the air flow direction control device 18 to detect the status (e.g., position) of the air flow direction control device 18.

[0035] In the present embodiment, the controller 40 (see FIG. 1) is coupled to the air moving device 16, air flow direction control device 18 and the air purification device 20. The controller 40 may use the inputs from the sensor 14 to operate the air moving device 16 to meet the required performance parameters such as, required ventilation rate, required operating speed and so forth. Moreover, based on the quality of the air above the active side 30 of the cooktop 28, the air flow direction

control device 18 may be directed to a position for operating the air flow direction control device 18 in the exhaust or recirculation modes. Similarly, the controller 40 may implement closed loop control of the air moving device 16 and/or the air flow direction control device 18 by reference to inputs from sensors 114 and 116.

[0036] In another embodiment, the air purification device 20 is configured to reduce the content of certain chemical compositions 34 of the air displaced by the air moving device 16. Exemplary air purification devices 20 include, without limitation, an active device, a corona device, a UV air purification device and so forth. Moreover, the air purification device 20 may have a filter to facilitate odor destruction and microorganism destruction of target air constituents or compositions as sensed by the sensor 14 above and adjacent to the active side 30 of the cooktop 28. As will be appreciated by those skilled in the art, the odor and microorganism destruction may also be achieved through suitable filters such as, activated carbon. Alternatively, other systems could be used, for example, a UV radiation system, catalytic oxidizer, ozone generator and so forth. As will be appreciated by those skilled in the art, the system may convert a part of the UV output from the UV based odor and microorganism destruction system into visible light by using a transparent object with suitable phosphor coating. This may be used for illuminating the cooking space simultaneously along with odor and microorganism destruction.

[0037] The present configuration of the ventilating system offers an extremely flexible platform for various types of logical operation of the system components based upon sensed, input and reference parameters of the types described above. For example, FIG. 4 illustrates exemplary control logic 118, in accordance with but one aspect of the present techniques, for identifying the air circulation mode of the air flow direction control device 18 in a kitchen ventilating system 10 based on an air quality parameter. The control logic begins with step 120, at which an air quality parameter is sensed via a sensor 14 over the cooktop 28. The air quality parameter (AQ parameter) may be qualitative or quantitative attributes of the target chemical composition 34 present in the air above the active side 30 of the cooktop 28. The target chemical composition 34 may include, without limitation, cooking fumes, vapors, smoke and combustion byproducts that are being generated as a result of

cooking activities of a user of the cooking apparatus. Next, at step 122 the information about the AQ parameter is read and stored in the system. At step 124, the AQ parameter is compared with a reference value of the AQ parameter for calibrated pure (i.e. acceptable quality) air. If the AQ parameter sensed at step 120 is less than the desired value, the system returns to the entry point 120. However; if the AQ parameter sensed at step 120 is more than the desired value, the system proceeds to the next step.

[0038] As shown in step 126, the system calculates a ratio of the AQ parameter as sensed on a first side (AQ1) of the active zone 30 of the cooktop 28 and the second side (AQ2) of the active zone 30 of the cooktop 28. Further, at step 128, this ratio is compared with a first reference value of the ratio of the AQ parameters on the two sides. As shown at step 130, if the calculated ratio is greater than the first reference value, the system sets the airflow direction control device 18 for first side in exhaust mode and the sets the airflow direction control device 18 for second side in re-circulation mode or in off mode; if the calculated ratio is less than the first reference value, the system proceeds to the step 132.

[0039] Next, at step 132 the calculated ratio of the AQ parameter on the two sides is compared with a second reference value of the ratio of the AQ parameters on the two sides. At step 134, if the calculated ratio is less than second reference value, the system sets the airflow direction control device 18 for first side in re-circulation mode or off mode and the sets the airflow direction control device 18 for second side in exhaust mode. If the calculated ratio is greater than the second reference value, the system proceeds to the step 136. At step 136, the system sets the airflow direction control device 18 for first side in exhaust mode and the sets the airflow direction control device 18 for second side in exhaust mode with reference to the limits 138 defining the air circulation modes for the two sides of the air flow direction control device 18.

[0040] As another example, the present system configuration affords site-specific operation programming. As mentioned above, the various sides and zones of the cooktop may be positioned adjacent to walls, open areas, and so forth. Similarly, the

cooktop may be provided at specific heights above the cooktop, and the cooktop and system housing may be of various sizes. FIG. 5 illustrates exemplary logic 140 for identifying an operating configuration for the kitchen ventilating system 10 based upon such installation site parameters, as well as system criteria, such as input duct parameters. The sequence of steps for selecting an operating system based on the duct parameters is indicated generally by reference numeral 142. In general, the sequence begins at step 144 where the duct length is read by the system. Next, at step 146 the duct cross-section is made available to the system. At step 148 and step 150 the number of bends in the duct and the type of filter used for the odor removal of the air are specified as input parameters. Further, at step 152 the venting option for the current duct is specified. In practice, these various inputs may be provided manually at the time of system setup or configuration. At step 154 the operating configuration for the kitchen ventilation system 10 based on the duct inputs and the internal references 50 as discussed above may be decided. Of course, more or fewer inputs may be considered in the configuration, as desired.

[0041] Following the selection of the operating configuration based on the input duct parameters, the characteristics of the system based on the installation parameters are identified in accordance with the exemplary step sequence 162. In general, the sequence begins at step 164 where the width of the hood is read by the system. At step 166 and step 168 the room dimensions to define the volume and the installation location are specified as input parameters respectively. Further, at step 170 and step 172 the inputs regarding the height of the system above the cooktop and the type of the fuel used for the cooking apparatus are specified respectively. Here again, such inputs may be provided manually at the time of setup or configuration of the system. At step 174 the operating parameters for the kitchen ventilation system 10 based on the installation site parameters may be decided. Here again, more or fewer of these exemplary factors may be considered for system configuration.

[0042] FIG. 6 illustrates a graphical representation 156 of exemplary settings available for a kitchen ventilating system of the type shown in FIG. 1, based upon input duct parameters, and the various other factors discussed above. Typically, the system settings are available based on required air static pressure 158 and required

flow rate (e.g., in cubic feet per minute, CFM, or cubic meters per minute) or the air velocity 160 from the plurality of reference settings 156 available for the system. FIG. 7 illustrates a graphical representation of the reference curves 176 that may be used for deciding the operating system based on the installation site parameters. In general the system settings are available based on required air static pressure 178 and required air flow rate or the air velocity 180 from the plurality of reference settings 176 available for the system.

[0043] In the present embodiment illustrated in FIG. 8 the operating system and the settings for the system based on the input duct parameters and the installation site parameters may be decided by combining the response of the settings of FIG. 6 and FIG. 7. The system settings for the operating point are selected from a plurality of reference settings 184 based on the static pressure 186 and the flow rate or velocity 188 of the combined response. Once determined, the system may be set to operate in accordance with the selected curves, which may be stored in the reference settings discussed above, thus configuring the system specifically to the installation.

[0044] FIG. 9 and FIG. 10 represent exemplary air circulation modes 190 of an air flow direction control device 18 for a kitchen ventilating system of FIG. 1. Typically, the air flow direction control device 18 is disposed upstream of the air moving device 10 in a location 194 within the housing 12 of the kitchen ventilating system 10. As noted above, the target air above the active side 30 of the cooktop 28 is displaced by the air moving device 16. FIGs. 9 and 10 illustrate the air moving device 16 in somewhat greater detail as a fan having an inlet 196 and an outlet 198 of the air moving device 16. Subsequently, based on the signals received from the control circuitry 40 (see FIG. 1), the air may be directed in the flow direction 200 as shown in FIG. 9 by placing the air flow direction control device 16 in a first position 110 to operate the air flow direction control device 16 in an exhaust mode 192. Alternatively, as shown in FIG 10, the air may be directed in the flow direction 204 by placing the air flow direction control device 16 in a second position 112 to operate the air flow direction control device 16 in a re-circulation mode 202.

[0045] FIG. 11 depicts the flow of information 206 of internal references and inputs for the controller 44 of the control circuitry 40 of the kitchen ventilation system 10 for performing control operations of the type discussed above. The controller 44 receives the sensor inputs 208 from the air above cooktop 28, air moving device 16, air flow direction control device 18 and the air purification device 20. The sensor inputs 208 may include, without limitation, chemical composition 34 of the target air, heat measurements 210, temperature data 36, humidity data 38, light intensity of the lamp 212, PIR motion of PIR sensor 214, UV intensity 216 of the UV source 26, pressure difference 218 for the filter used for the air purification device 20 and RPM 220 of the air moving device 16.

[0046] Further, as discussed above, the controller 40 may have a set of internal references 50 to control and operate the various components of the kitchen ventilation system 10. The controller 40 may also receive inputs 64 from a user of the system for providing flexibility to the user for operating the system.

[0047] FIG. 12 illustrates an exemplary overview 222 of the display system 66, the power output 224 from the controller 44, and the output signals 68 from the controller 44 of the control circuitry 40 of the kitchen ventilation system 10. The display system 66 includes, without limitation, air moving device speed LED or display 78, AQ sensitivity LED or display 80, timer display 82, replace filter display 84 and power on LED or display 86.

[0048] In the present embodiment, the power output 224 from the controller 44 may include, without limitation, power output for air moving device 226, power output for air flow direction control device 228, power output for excitation of sensors 230, power output for lamp 232 and power output for the UV system 234. Further, the signal output 68 transmitted from the controller 44 to the components of the kitchen ventilation system 10 may include air moving device speed 70, air moving device status 72, air flow direction control device status 74, UV source status and so forth.

[0049] As will be appreciated by those skilled in the art, the present system thus allows for closed loop control for managing air above a cooktop 28 based on assessing the status of air quality by monitoring the level of the target constituents present in the air. The system is typically installed and used near a cooking appliance such as, cooking range, oven, or grill for moving and treating cooking fumes, vapors, smoke and other combustion products resulting from the cooking activities of a user of the system. Further, the system as described in the various embodiments hereinabove, uses the response of the air quality sensors to generate suitable control and display signals to facilitate controlling various elements such as, without limitation, operating speed and status of the air moving device 14, opening or closing of the air flow direction control device 16, activation and control of odor removal system and so forth.

[0050] In addition, the system also provides flexibility to a user for deciding the operating parameters by specifying certain user-defined inputs. As noted above, the system operates at an operating point determined by the sensing and control system which includes parameters such as, operating speed, operating duration and so forth, thus reducing the acoustic noise of the system during operation. Similarly, the system provides a very flexible platform that may be specifically adapted to the configuration and aspects of the site in which the system is installed to provide optimum performance.

[0051] The various aspects of the methods described hereinabove have applications in other environments for managing air. The embodiments described hereinabove can be used in the heating, ventilating and air conditioning area for managing air and maintaining required air characteristics in a space for human occupancy. The techniques may also be employed in a variety of appliances for example, a refrigerator deodorizing system may be controlled using a sensor to detect food odors, a clothes washing machine may be controlled by sensing a target compound that may be an ingredient of the washing agent to evaluate the options for the operation of the washing machine and so forth.

[0052] While only certain features of the invention have been illustrated and described herein, many modifications and changes will occur to those skilled in the art. It is, therefore, to be understood that the appended claims are intended to cover all such modifications and changes as fall within the true spirit of the invention.